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SHIFT MECHANISM  
FOR A MANUAL PLANETARY TRANSMISSION

TECHNICAL FIELD

**[0001]** This invention relates to transmission controls and, more particularly, to shift mechanisms for a manual planetary transmission.

5 BACKGROUND OF THE INVENTION

**[0002]** Manual transmissions are being reconsidered because they provide a more efficient powertrain due to the reduction in the amount of fluid power that is required to control the automatic shifting planetary transmission. Planetary manual transmissions are being considered because  
10 of the lower cost and mass of planetary gears relative to countershaft gears. When using planetary transmissions, it is necessary to engage two or more torque-transmitting mechanisms substantially simultaneously in order to produce a usable drive ratio within a planetary gear arrangement. In these more conventional automatic transmissions, the torque-transmitting  
15 mechanisms are fluid-operated devices controlled by a plurality of valves and electronic controls. This permits the selective actuation and deactuation of the torque-transmitting mechanisms.

**[0003]** Manual planetary transmissions, however, employ synchronizer type torque-transmitting mechanisms, which are mechanical in nature and are  
20 generally controlled by a shift rod, which is under the manipulative control of the operator. In manual planetary transmissions, it is necessary to engage and/or disengage two synchronizers to establish a drive ratio through a planetary gear arrangement. One such mechanical shift control mechanism is shown in U.S. Serial No. 10/443,451, filed May 22, 2003, in the name of  
25 Haka and assigned to the assignee of this application.

## SUMMARY OF THE INVENTION

**[0004]** It is an object of the present invention to provide an improved shift mechanism for a manual planetary transmission.

**[0005]** In one aspect of the present invention, the shift mechanism  
5 employs a plurality of plate members having slotted openings formed therein to control one or more shift rails.

**[0006]** In another aspect of the present invention, one of the plate members is a neutral plate, which maintains the shift rods in a neutral position prior to shifting from one ratio to another.

10 **[0007]** In yet another aspect of the present invention, each of the plate members has a surface configuration, which will move all of the plates between the shifted plate and the neutral plate upward to release the control rods from the neutral plate.

**[0008]** In still another aspect of the present invention, the surface  
15 configurations are elongated indentations formed in each plate member.

**[0009]** In yet still another aspect of the present invention, the plates are nested on the surface configurations.

**[0010]** In a further aspect of the present invention, each of the plates has a control slot for each of the shift rods necessary to control the synchronizers  
20 of a manual planetary transmission.

**[0011]** In a still further aspect of the present invention, each of the control slots has a neutral slot and a slot perpendicular to the neutral slot.

**[0012]** In yet a further aspect of the present invention, each of the perpendicular slots will provide for continued neutral control or for a shift  
25 control for one of the shift control rods.

## DESCRIPTION OF THE DRAWINGS

**[0013]** FIG. 1 is a schematic representation of a powertrain describing a manual planetary transmission capable of providing six forward speed ratios  
30 and one reverse speed ratio.

[0014] FIG. 2 is a diagrammatic representation of a portion of the shift control mechanism showing the plates in a neutral position.

[0015] FIG. 3 is a view similar to FIG. 2 wherein one of the control plates has been moved from the neutral position to an operable position.

5 [0016] FIG. 4 is a diagrammatic representation of the slot configuration in the reverse shift control plate for the reverse shift control mechanism.

[0017] FIG. 5 is a diagrammatic representation of the slot configuration for the 1-2 shift control plate of the shift control mechanism.

[0018] FIG. 6 is a diagrammatic representation of the slot configuration  
10 for the 2-4 shift control plate of the shift control mechanism.

[0019] FIG. 7 is a diagrammatic representation of the slot configuration for the 5-6 shift control plate of the shift control mechanism.

[0020] FIG. 8 is a diagrammatic representation of the slot configuration showing the 5-6 shift control plate moved relative to the stacked control  
15 plates to the shift ratio position.

[0021] FIG. 9 is a diagrammatic representation of the slot configuration for the 5-6 control plate wherein the control plate is shifted to the sixth ratio position.

[0022] FIG. 10 is a diagrammatic representation of an alternative  
20 configuration for the shift control mechanism.

[0023] FIG. 11 is a partial view of the configuration shown in FIG. 10 describing a portion of the shift control mechanism.

#### DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

25 [0024] Referring to the drawings, wherein like characters represent the same or corresponding parts throughout the several views, there is shown in FIG. 1 a powertrain 10 including a conventional engine 12, a conventional selectively operable input clutch or torque-transmitting mechanism 14, and a planetary gear arrangement 16. The planetary gear arrangement 16 includes

two planetary gearsets 18 and 20, which are combined to form a planetary arrangement.

[0025] The planetary gearset 18 includes a sun gear member 22, a ring gear member 24, and a planet carrier assembly member 26, which has a plurality of pinion gears 28 rotatably mounted on a planet carrier member 30 and disposed in meshing relationship with both the sun gear member 22 and the ring gear member 24.

[0026] The sun gear member 22 is continuously connected to a portion of a transmission housing 32 and is therefore held stationary continuously. The ring gear member 24 is connected with an input shaft 34, which is also connected with the input clutch or torque-transmitting mechanism 14. The planet carrier member 30 is drivingly connected with a mechanical torque-transmitting mechanism or synchronizer 36 and also with a mechanical torque-transmitting mechanism or synchronizer 38. The input shaft 34 is drivingly connected with a mechanical torque-transmitting mechanism or synchronizer 40.

[0027] Each of the mechanical torque-transmitting mechanisms 36, 38, and 40 are conventional synchronizer type shift mechanisms, which are well known in the art. The torque-transmitting mechanisms 36 and 40 are rotating type torque-transmitting mechanisms, which are generally referred to as clutches. The torque-transmitting mechanism 38 is a dual purpose synchronizer and provides a rotating type torque-transmitting mechanism when connected with the planet carrier member 30 and a stationary type torque-transmitting mechanism or brake when connected with the transmission housing 32.

[0028] The planetary gearset 20 is a gearset commonly referred as a Ravigneaux type gearset. This gearset 20 includes two sun gear members 42 and 44, a ring gear member 46, and a planet carrier assembly member 48. The planet carrier assembly member 48 includes a plurality of long pinion gears 50 and a plurality of short pinion gears 52. The long pinion gears 50

mesh continuously with the sun gear member 42 and the ring gear member 46. The short pinion gears 52 mesh continuously between the sun gear member 44 and the long pinion gears 50. Those skilled in the art will recognize that the planetary connection between the sun gear member 42 and the ring gear member 46 is a simple planetary gear connection while the connection between the sun gear member 44 and the ring gear member 46 is a compound connection.

**[0029]** The ring gear member 46 is continuously drivingly connected with a transmission output shaft 54, which in turn is connected to drive the vehicle wheels in a well known manner. The pinion gears 50 and 52 are rotatably mounted on a planet carrier member 56, which is drivingly connected with a portion of the mechanical torque-transmitting mechanism 40 and also drivingly connected with a portion of a mechanical torque-transmitting mechanism or synchronizer 58. The mechanical torque-transmitting mechanism 58 is a synchronizer type torque transmitter, which is effective to selectively connect the planet carrier member 56 to the transmission housing 32 and therefore operates as a brake.

**[0030]** As is well known, synchronizers have a neutral condition and at least one active condition. The torque-transmitting mechanisms 36, 40, and 58 all have a neutral condition and an active condition. In the active condition of torque-transmitting mechanism 36, the planet carrier member 30 is drivingly connected with the sun gear member 44. In the active condition of the torque-transmitting mechanism 40, the input shaft 34 is drivingly connected with the planet carrier member 56. In the active condition of the torque-transmitting mechanism 58, the planet carrier member 56 is connected with the stationary housing 32. Obviously, the torque-transmitting mechanisms 40 and 58 would not be engaged at the same time.

**[0031]** The torque-transmitting mechanism 38 is a three-position synchronizer having two active positions and a neutral position. In one active position, the synchronizer 38 provides a drive connection between the

planet carrier member 30 and the sun gear member 42. In another active position, the synchronizer or torque-transmitting mechanism 38 provides a braking connection between the sun gear member 42 and the transmission housing 32.

- 5    **[0032]**    The synchronizer 36 has two positions A and B, A being the neutral position and B being the drive connection position. The synchronizer 38 has three positions A, B, and C, C being the neutral position, A being the braking position, and B being the rotating drive connection. The synchronizer 40 has two positions A and B, A being the neutral position and  
 10    B being a drive position connecting the input shaft 34 to the planet carrier member 56. The synchronizer 58 has two conditions A and B, B being the neutral condition and A being the braking condition in which the planet carrier member 56 is connected with the transmission housing 32. The synchronizers 36, 40, and 58 are always shifted from neutral in one direction  
 15    of operation while the synchronizer 38 is shifted from neutral to an operating condition either side of neutral.

- [0033]**    Shown diagrammatically in FIG. 2 is a portion of a shift control mechanism incorporating four control shift plates 60, 62, 64, and 66, and a neutral plate 68. The neutral plate 68 is held stationary in the lateral  
 20    directions and is permitted to move vertically along a pair of pins or pegs 70 and 72. The plate 68 is urged downwardly by springs 74 and 76. The plate 60 is the reverse plate, plate 62 is the 1-2 shift control plate, the plate 64 is the 3-4 shift control plate, and the plate 66 is the 5-6 shift control plate.

- [0034]**    Also shown in FIG. 2 is a shift control rod 78, which is typical of  
 25    the four shift control rods necessary to operate the four synchronizers 36, 38, 40, and 58. The shift control rod 78 is movable in the direction of Arrow D and includes a vertical or upright pin portion 80, which is engaged with each of the plates 60, 62, 64, 66, and 68. The engagement with the plate 68 is by way of a circular opening 82. Another circular opening 84 can

also be seen, which is the opening for the engagement of a pin member 86 of another control rod, not shown.

[0035] As seen in FIG. 3, the shift control plate 66, which is the 5-6 control plate, has been moved from the neutral position shown in FIG. 2 to the fifth ratio position. Each of the plates 60, 62, 64, 66, and 68 has a pair of longitudinally extending indentations or surface characteristics 87 and 88. As seen in FIG. 2, these indentations 87 and 88 are aligned or nested such that the plates are stacked substantially in contact. However, when one of the plates, as shown in FIG. 3, plate 66, is moved laterally, the indentations 87 and 88 move laterally with that plate while the remaining indentations are moved vertically relative to the plate 66.

[0036] The plates 60, 62, 64, and 68, as seen in FIG. 3, are moved a distance of twice the height of the indentations 87 and 88. When the plate 66 moves laterally, the indentations 87 and 88 move out of respective stationary control indentations 90 and 92 and therefore lift all of the plates one height of the indentation. Also, during this lateral movement, the indentations 87 and 88 of the plate 64 abut a flat surface on the plate 66 which is therefore also move vertically the height of the indentations 87 and 88. Thus, the stack of plates above the plate 66 are moved vertically a distance equal to the height of twice of the indentations.

[0037] This vertical movement releases the control pins for the control rods from the openings in the neutral plate 68 and thereby will permit the control rods to move relative to the neutral plate and thereby control the shifting of the synchronizers 36, 38, 40, and 58, respectively. The control rod 78 is effective to control the operation of the synchronizer 36 and is therefore moved with the 1-2 shift plate 60 and the 3-4 shift plate 64.

[0038] FIG. 4 is a representation of the reverse plate 60. The reverse plate 60, as does each of the control plates, has four control slots 94, 96, 98, and 100. The control slot 94 has a neutral slot portion 102, the control slot 96 has a neutral slot portion 104, the control slot 98 has a neutral slot portion

106, and the slot 100 has a neutral slot portion 108. Each of the control slots 94, 96, 98, and 100 also have respective shift control slots 110, 112, 114, and 116.

**[0039]** As seen in FIG. 4, the control pin 80 is located in the slot 96, which is the control slot for the synchronizer 36. The control slot 94 houses the control pin 86, the control slot 98 houses a control pin 118, and the control pin 100 houses a control pin 120. The control pin 86 is effective to control the synchronizer 40. The control pin 118 is effective to control the synchronizer 38. The control pin 120 is effective to control the synchronizer 58. If the plate 60 is moved in the direction of Arrow R, the pins 86 and 80 will remain in the slot 110 and in the neutral slots 102 and 104. However, the pins 118 and 120 will be moved to the right in the slots 114 and 116. This will cause manipulation of the synchronizers 38 and 58. The synchronizer 58 will ground the carrier 56 at position 58B (FIG. 1) and the synchronizer 38 will connect the carrier 30 with the sun gear member 42. This will establish a reverse drive between the sun gear member 42 and the ring gear member 46 and therefore with the output shaft 54.

**[0040]** In FIG. 5, the slots 94A, 96A, 98A, and 100A of the shift control plate 62 are shown. The slot 94A aligns in the neutral position with the slot 94, the slot 96A aligns in the neutral position with the slot 96, the slot 98A aligns in the neutral position with the slot 98, and the slot 100A aligns in the neutral position with the slot 100. The plate 62 is manipulated whenever a neutral-to-first or a neutral-to-second shift is desired. For a shift to first gear, the plate 62 is shifted downward, as seen in FIG. 5, and for the second ratio, the plate 62 is shifted upward, as seen in FIG. 5, in the direction of Arrow E.

**[0041]** The shifting of the plate 62 will enforce the plates 60 and 68 to move upward thereby releasing the pins 80, 86, 118, and 120. The manipulation of the plate 62 downward in the direction of Arrow E will cause the pin 80 to move rightward in the slot 96A and also cause the pin



120 to move rightward in the slot 100A. This will cause manipulation of the synchronizers 36 and 58 while retaining the synchronizers 38 and 40 in the neutral position as controlled by the slots 94A and 98A as well as the neutral slot 102 and 106.

- 5   **[0042]**     Manipulation of the plate 62 to the second ratio position; that is, upward as represented by Arrow E, the pin 80 will be moved rightward in the slot 96A and the pin 120 will be moved leftward in the slot 100A. With the manipulation of the pin 80, the synchronizer 36 will again be engaged to provide a drive connection at position 36B and the synchronizer 58 will be  
10   manipulated to provide a braking connection between the housing 32 and position 58C. The pins 118 and 86 will again be retained in the neutral position by the slots 94A and 98A and the neutral slots 102 and 106.

- [0043]**     The slot configuration of the 3-4 shift control plate 64 is shown in FIG. 6. The 3-4 shift control plate 64 has formed therein slots 94B, 96B,  
15   98B, and 100B, which are aligned in a neutral position with the slots 94, 94A, 96, 96A, 98, 98A, and 100, 100A. The 3-4 shift control plate 64 is manipulated by the control mechanism when the operator desires to establish either the third forward speed ratio or the fourth forward speed ratio. To establish the third forward speed ratio, the plate 64 is moved downward in  
20   the direction of Arrow F such that the pin 80 will move rightward in the slot 96B, the pin 118 will move rightward in the slot 98B, and the pins 120 and 86 will remain in the neutral position. As the pins 80 and 118 move rightward, they are also retained along the neutral plane in the respective neutral slots 104 and 106 of the plates 60, 62, and 66.

- 25   **[0044]**     When the plate 64 is manipulated upward in the direction of Arrow F, the fourth forward speed ratio will be established. During upward manipulation of the plate 64 relative to the other plates in the stack, the pin 86 will be moved rightward along the slot 94B, the pin 80 will be moved rightward along the slot 96B, and the pins 118 and 120 will remain in the  
30   neutral position as controlled by the slots 98B, 100B, 106 and 108. During

this manipulation, the synchronizer 40 will be manipulated to engage the input shaft 34 with the planet carrier member 56 and will manipulate the synchronizer 36 to engage the planet carrier member 30 with the sun gear member 44. This will provide two forward input rotations to the

5 Ravigneaux planetary gearset 20, which will result in a forward rotation of the output shaft 54.

[0045] The slot configuration of the 5-6 shift control plate 66 is shown in FIG. 7. The plate 66 is moved downward in the direction of Arrow G to the fifth position and upward in the direction of Arrow G from the neutral  
10 position to the sixth position.

[0046] When the plate 66 is moved downward to the fifth position, as shown in FIG. 8, the pin 86 is moved rightward by the slot 94C while remaining in the neutral slot 102. The pin 118 is moved rightward in the slot 98C while remaining in the neutral slot 106. This results in engagement  
15 of the synchronizer 40 between the input shaft 34 and the planet carrier member 56, which was also done in the fourth ratio, and the manipulation of the synchronizer 38 to connect the planet carrier member 30 with the sun gear member 42.

[0047] As in fourth gear, this will provide two forward input drives to  
20 the Ravigneaux planetary gearset 20 resulting in a forward rotation of the output shaft 54. During engagement in the fifth ratio, with the plate 66 moved downward in the direction of Arrow G, the pin 80 is retained in a neutral position by the slots 96C and 104 and the pin 120 is retained in the neutral position by the slots 100C and the neutral slot 108.

25 [0048] As seen in FIG. 9, the plate 66 has been moved upward relative to the stack of plates in the direction of arrow G such that the pin 86 is moved rightward by the interaction of the slots 94C and 102, the pin 120 is moved leftward by the interaction of the slots 100C and 108, while the pins 80 and 118 remain in the neutral position by the interaction of their  
30 respective slots 96C, 104 and 98C, 106.

[0049] The manipulation of the plate 66 upward in the direction of Arrow G will result in the pin 118 being returned to the neutral position while the pin 120 is moved leftward. The pin 120 manipulates the synchronizer 58 to provide a ground connection at the sun gear member 42 while the synchronizer 38 is returned to the neutral thereby disconnecting the planet carrier member 30 from the sun gear member 42. With the sun gear member 42 held stationary and the planet carrier member 56 driven by the input shaft 34 through the synchronizer 40, the Ravigneaux gearset 20 is placed in a high overdrive condition thereby resulting in a forward rotation of the output shaft 54.

[0050] An alternative embodiment of a shift control mechanism 200 is shown in FIG. 10. In the shift control mechanism 200, a plurality of tubular members 202, 204, 206, and 208 are nested and they surround the transmission, which is not shown. Each of the tubular members 202, 204, 206, and 208 have respective control connectors 210, 212, 214, and 216. The control connectors each have respective slot portions 220, 222, 224, and 226.

[0051] A conventional shift control mechanism having a rod end is manipulable among the slots 220, 222, 224, and 226 to establish which of the tubular members 202, 204, 206, and 208 will be manipulated by the control mechanism. Each of the tubular members 202, 204, 206, and 208 have slots formed therein, one set of the slots is shown in FIG. 10. The slot configurations are substantially identical with the slot configurations shown above in FIGS. 4 through 7. The rotation of the tubular members 202, 204, 206, and 208 results in similar movement of control pins 80, 86, 118, and 120, and thereby manipulation of the synchronizers 36, 38, 40, and 58.

[0052] It should be appreciated that similar type control mechanisms, as that shown in FIG. 11, can be employed to manipulate the plates 60, 62, 64, and 66. It should now be apparent that a conventional manual shift linkage having a pin 228 operable to engage in the slots 220, 222, 224, and 226 and

manipulable east-west to make a slot selection and north-south to make a gear selection by rotating the respective tubular member 202, 204, 206, or 208. This is a standard shift pattern in manual transmission controls. A similar control can be employed to manipulate the plates 60, 62, 64, and 66  
5 fore and aft and transversely as desired by the operator to control the gear ratio in the vehicle transmission. If desired, those skilled in the art will be aware that a conventional manual control mechanism (i.e. rod and linkage or flexible push-pull cable) can be employed to permit manual control of the transmission. In the alternative, a conventional hydraulically actuated  
10 system, or a conventional electrically actuated system, or a conventional electro-hydraulically actuated system can be employed.

**[0053]** It should be obvious to those skilled in the art that this shift mechanism can be applied to other planetary gear arrangements of any number of forward or reverse speeds, the only difference would be the  
15 number of plates required and the specific direction of the slots to provide the desired shift rail motion for each specific ratio.